M3H Group (1)
Application Note
I^2C Interface
(I2C-B)
arbitration

Outlines

This application note is a reference material for developing products using the arbitration function in I2C interface (I2C) function of M3H Group (1).
This document helps the user check operation of the product and develop its program

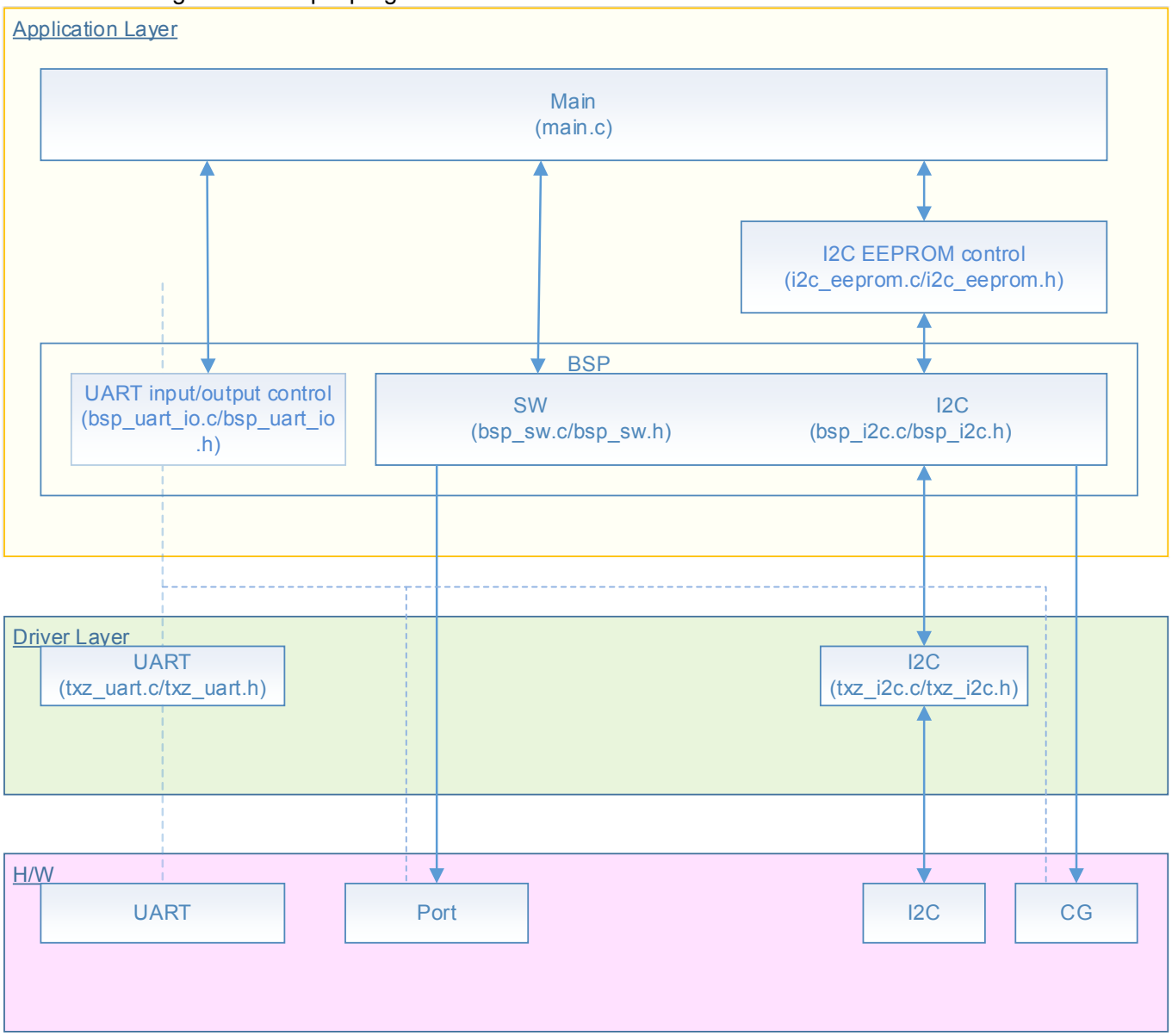
Target sample program: I2C_EEPROM_arbitration

Table of Contents

1. Preface

This sample program is used to check the operation of the I2C communication function.
First write data to I2C EEPROM. The function to read the written data via multiple CPUs is executed by the terminal software on the host PC via USB-UART.

Structure diagram of Sample program



2. Reference Document

- Datasheet
  TMPM3H group (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  I2C interface (I2C-B) Rev2.0 (Japanese edition)
- Other reference document
  TMPM3H(1) Group Peripheral Driver User Manual (Doxygen)

3. Function to Use

IP	Channel	Port	Function / operation mode
I2C interface	ch0	PC0 (I2C0SCL) PC1 (I2C0SDA)	I2C mode
Asynchronous communication	ch0	PA1 (UT0TXDA) PA2 (UT0RXD)	UART mode
Input and Output ports		PN1 (Input port)	Input

4. Target Device

The target devices of this application note are as follows;

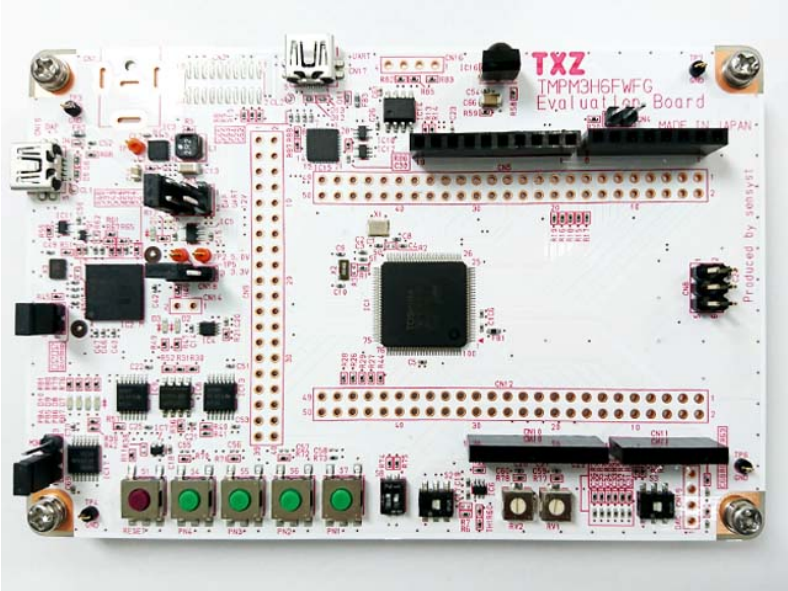
TMPM3H6FWFG	TMPM3H6FUFG	TMPM3H6FSFG
TMPM3H6FWDFG	TMPM3H6FUDFG	TMPM3H6FSDFG
TMPM3H5FWFG	TMPM3H5FUFG	TMPM3H5FSFG
TMPM3H5FWDFG	TMPM3H5FUDFG	TMPM3H5FSDFG
TMPM3H4FWUG	TMPM3H4FUUG	TMPM3H4FSUG
TMPM3H4FWFG	TMPM3H4FUFG	TMPM3H4FSFG
TMPM3H3FWUG	TMPM3H3FUUG	TMPM3H3FSUG
TMPM3H2FWDUG	TMPM3H2FUDUG	TMPM3H2FSDUG
TMPM3H2FWQG	TMPM3H2FUQG	TMPM3H2FSQG
TMPM3H1FWUG	TMPM3H1FUUG	TMPM3H1FSUG
TMPM3H1FPUG	TMPM3H0FSDUG	TMPM3H0FMDUG

* This sample program operates on the evaluation board of TMPM3H6FWFG.
If other function than the TMPM3H6 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.
The BSP related file is dedicated to the evaluation board (TMPM3H6). If other function than the TMPM3H6 one is checked, the BSP related file should be changed properly.

5. Conditions for Correct Operation

Used microcontroller TMPM3H6FWFG
Used board TMPM3H6FWFG Evaluation Board (Product of Sensyst)
Unified development environment IAR Embedded Workbench for ARM 8.11.2.13606
Unified development environment µVision MDK Version 5.24.2.0
Terminal software Tera Term V4.96
Sample program V1100

Evaluation board (TMPM3H6FWFG Evaluation Board) (Top view)



For purchasing the board, refer to the following homepage. (http://www.chip1stop.com/)

6. Evaluation Board Setting

Two evaluation boards should be prepared.
The following connections should be done.

Common connections for Board A and Board B

CN5		
Use	Through-hole No.	Setting
UART(RXD)	9-10	Connection
UART(TXD)	11-12	Connection

Board A

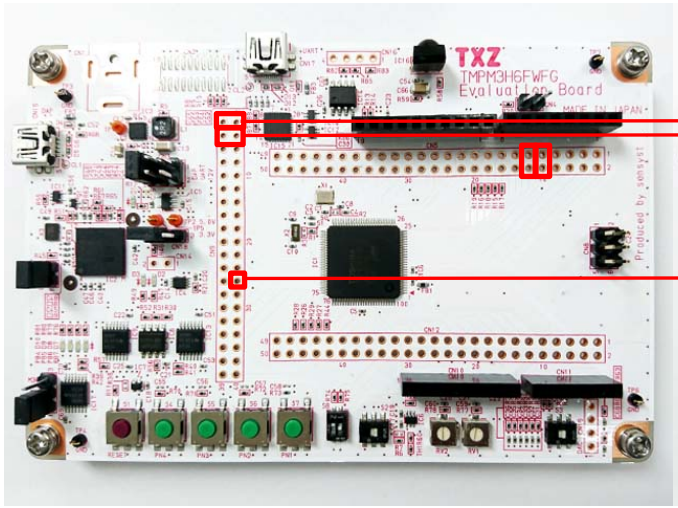
CN9		
Use	Through-hole No.	Setting
I2C(SCL)	1-2	Connection
I2C(SDA)	3-4	Connection

Board B

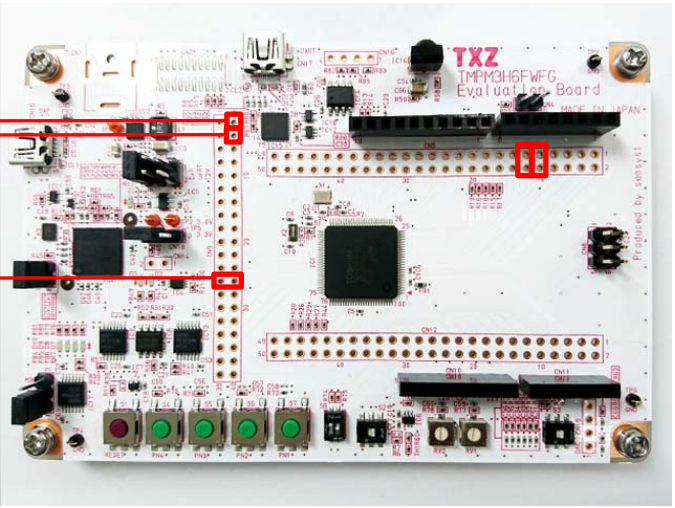
CN9		
Use	Through-hole No.	Setting
Push SW(S7)	25-26	Connection

Connections between the boards
Board A CN9 No2 and Board B CN9 No2 should be connected.
Board A CN9 No4 and Board B CN9 No4 should be connected.
Board A CN9 No26 and Board B CN9 No26 should be connected.

Board A



Board B



7. Operation of Evaluation Board

"/* #define BOARD_B */ " of "main.c" in the program which is written to Board B should be enabled.
The USB_UART pins of the boards and the PC should be connected with USB cables.
The PC executes the communication setting after start-up of the terminal software (Tera Term).
The reset button should be pushed down on Board B.
The communication starts according to the command which is input.
For the details of the operation, refer to "Sample Program Main Operation".

8. Outline of I^{2}C Interface function

The I2C can operate as a transceiver circuit of 1ch (SCL, SDA) in 1 unit circuit.

8.1. Clock Supply

When using I2C, please set a clock enabling bit corresponding with the fsys supply on/off register A (***[CGFSYSENA]***) or B (***[CGFSYSENB]***) and fc supply on/off register (***[CGFCEN])*** as “1” (clock supply). Please refer to "Clock Control and Operation Mode" of the reference manual for the details.

9. Sample Program

When SW (S4) is ON, an event procedure which uses the I2C function is executed. Then the following operations can be checked using the I2C interface; data read from the I2C EEPROM device, detection of generation of Bus busy error, and detection of generation of Bus arbitration error.
Each event procedure can be checked by displaying its status on the terminal software.

9.1. Initialization

The following initialization is done after power is supplied.
The port setting is executed after the initialization of each clock setting, the watchdog timer setting and the clock setting.

9.2. Sample program main operation

After the initialization, the “main” function is executed, and the following initialization is done.
1. BSP (Board Support Package) initialization
2. Application initialization
3. Initialization of the I2C interface for an EEPROM device.

After the above procedure, the following operations should be done on the terminal software (Tera Term) on the PC.
At first, when the switch (S7) on Board B is pushed down, the characters "toshibaABCDEFGHIJKLMNOPQRST" are stored to the EEPROM device on Board A through the I2C interface.
At the second, when you press switch (S7) on evaluation board B, it will try to read EEPROM data of evaluation board A via I2C and read from address 0 for evaluation board A and address 4 from evaluation board B.

One of the four following operations is done according to the timing to write the I2C interface after the push-down of the switch (S7) on Board B;
(1) Board A: Read successful. Board B: Read successful.
(2) Board A: Bus busy error. Board B: Read successful.
(3) Board A: Read successful. Board B: Bus busy error.
(4) Board A: Read successful. Board B: Bus arbitration error.

"command >" is displayed on Tera Term at start-up. Then the switch (S7) should be pushed down on Board B to write the data. After that, every push-down of the switch (S7) on Board B executes the read and display of the data.

9.3. Output Example of Sample Program

When the sample program operates, the command results are shown as follows;

Board A

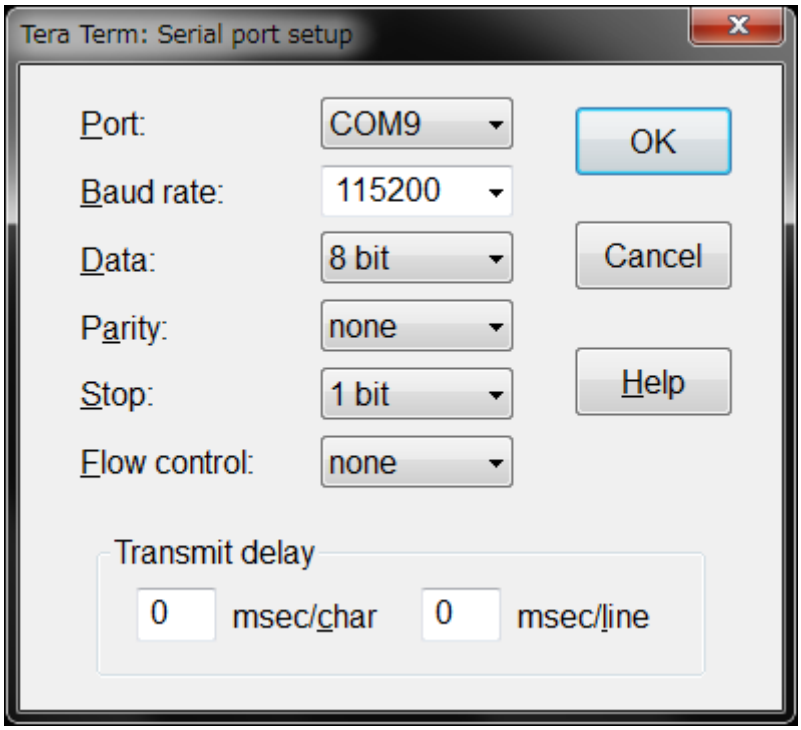
```
command >
write data >
toshibaABCDEFGHIJKLMNOPQRST
read data >
toshibaABCDEFGHIJKLMNOPQRST
read data >
 bus busy error !!
read data >
toshibaABCDEFGHIJKLMNOPQRST
read data >
toshibaABCDEFGHIJKLMNOPQRST
```

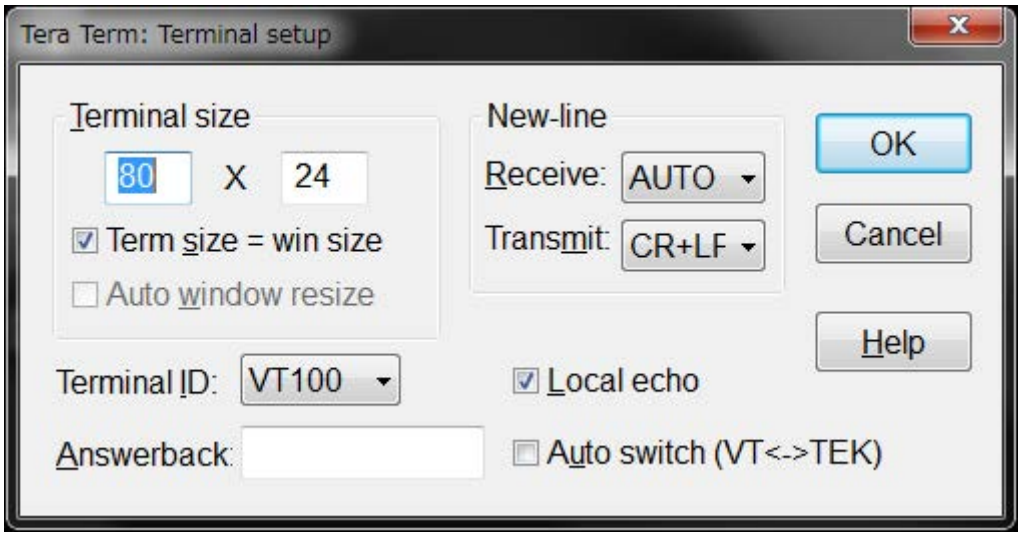
Board B

```
command >
write data >
toshibaABCDEFGHIJKLMNOPQRST
read data >
ibaABCDEFGHIJKLMNOPQRST
read data >
ibaABCDEFGHIJKLMNOPQRST
read data >
 bus busy error !!
read data >
 arbitration error !!
```

9.3.1. Setting Example of Terminal Software

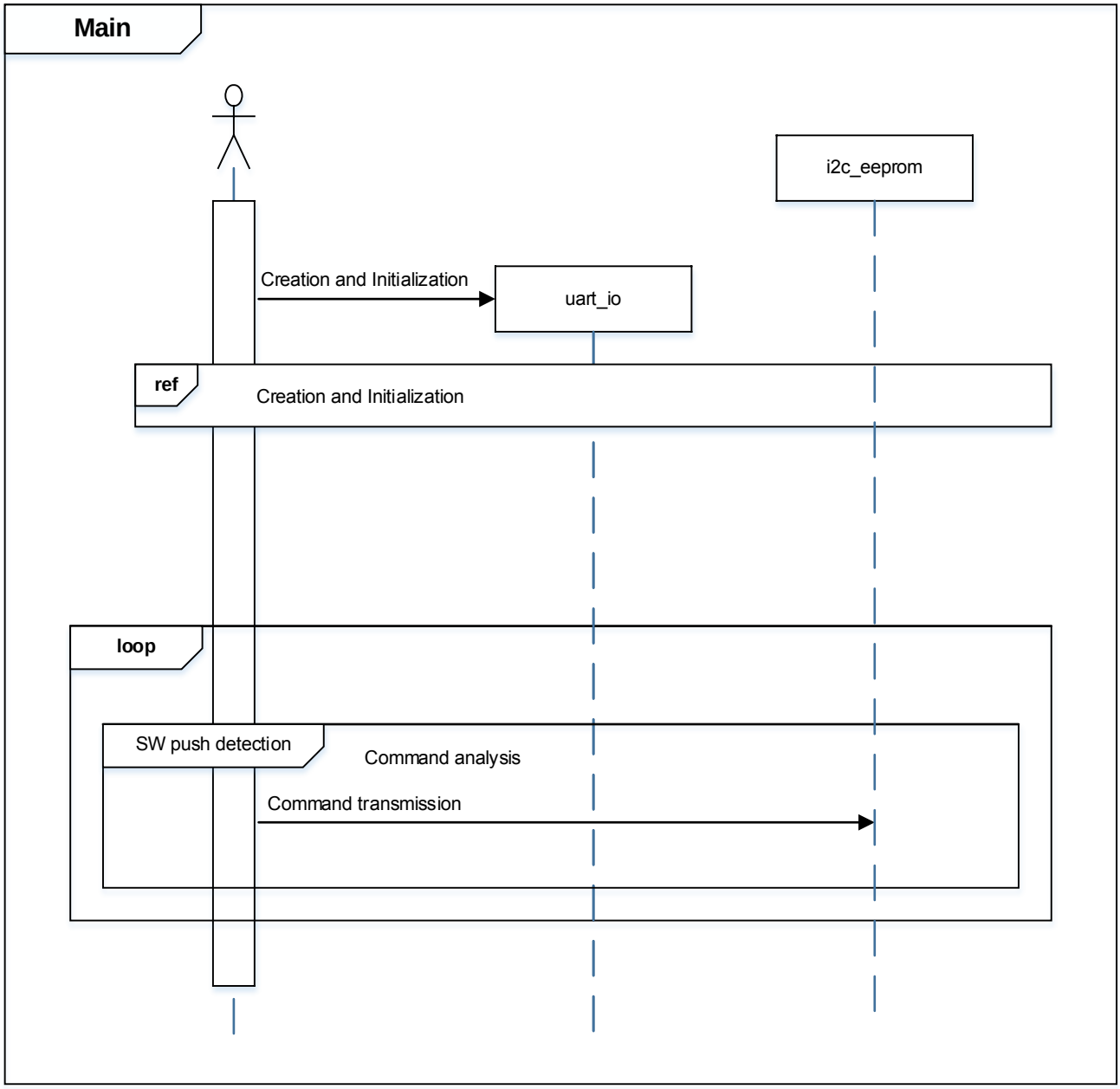
The operation of the terminal software (Tera Term) has been checked with the following settings.

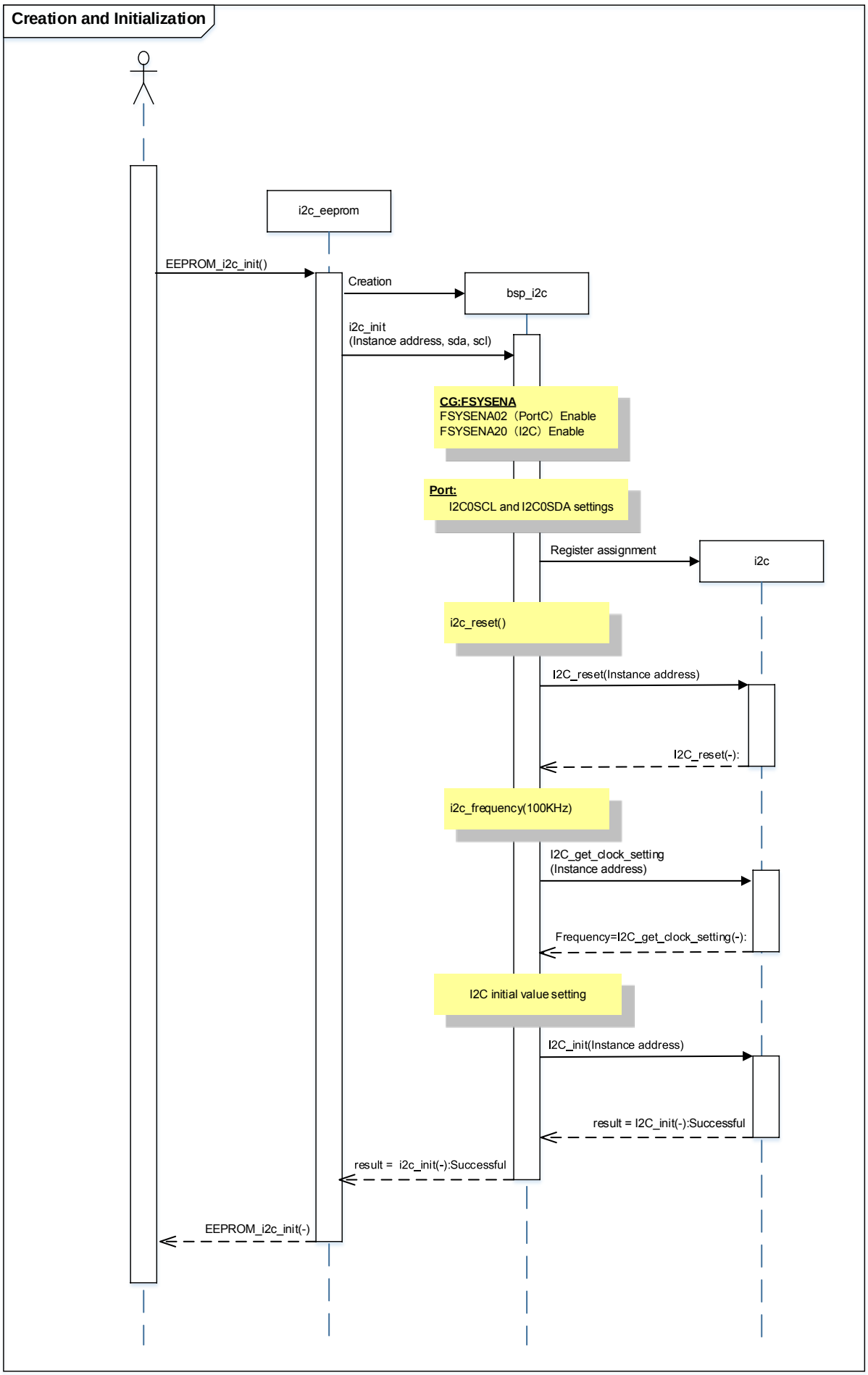




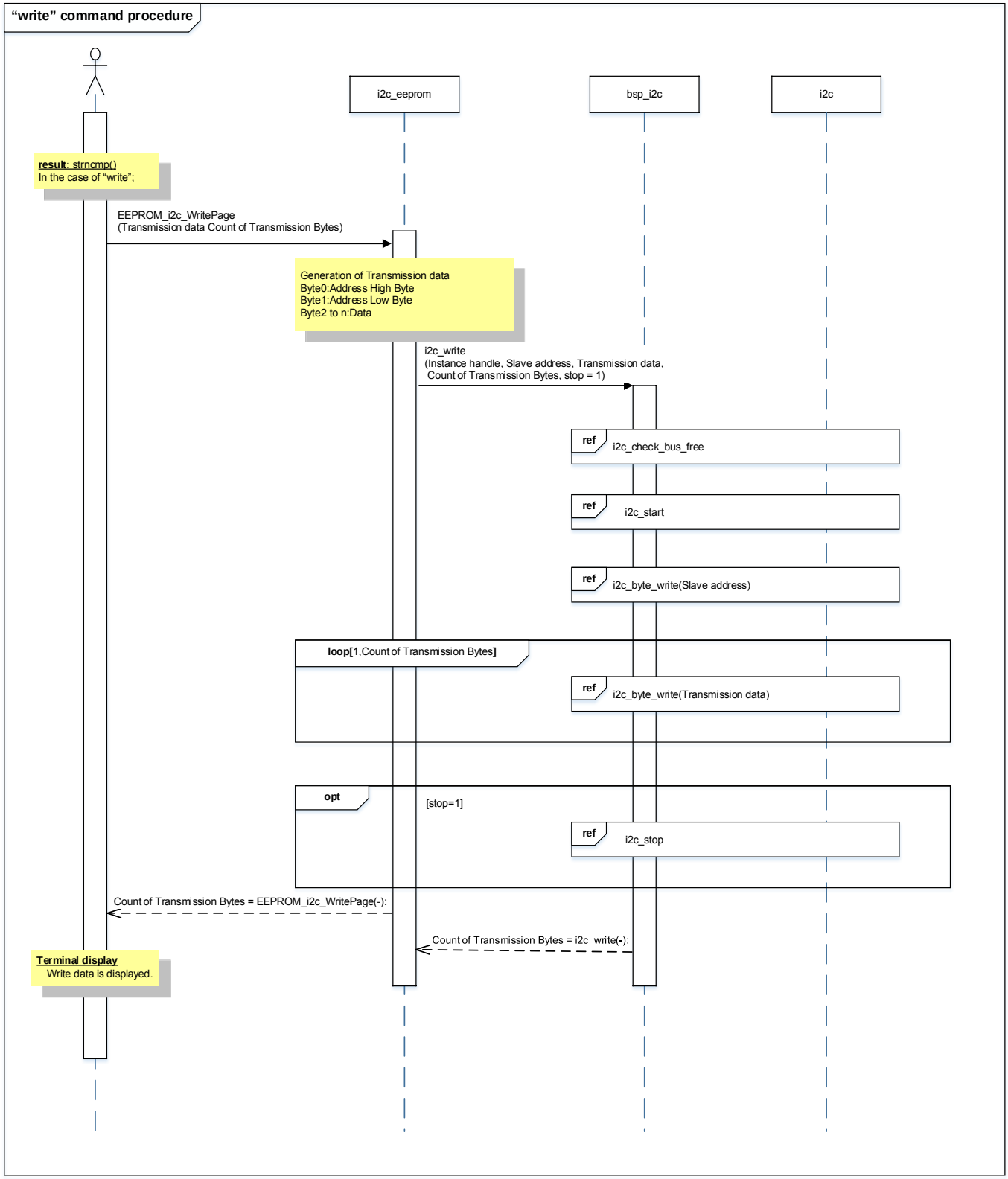
9.4. Operating Flow of Sample Program

The operating flows of the sample program are shown in the following;

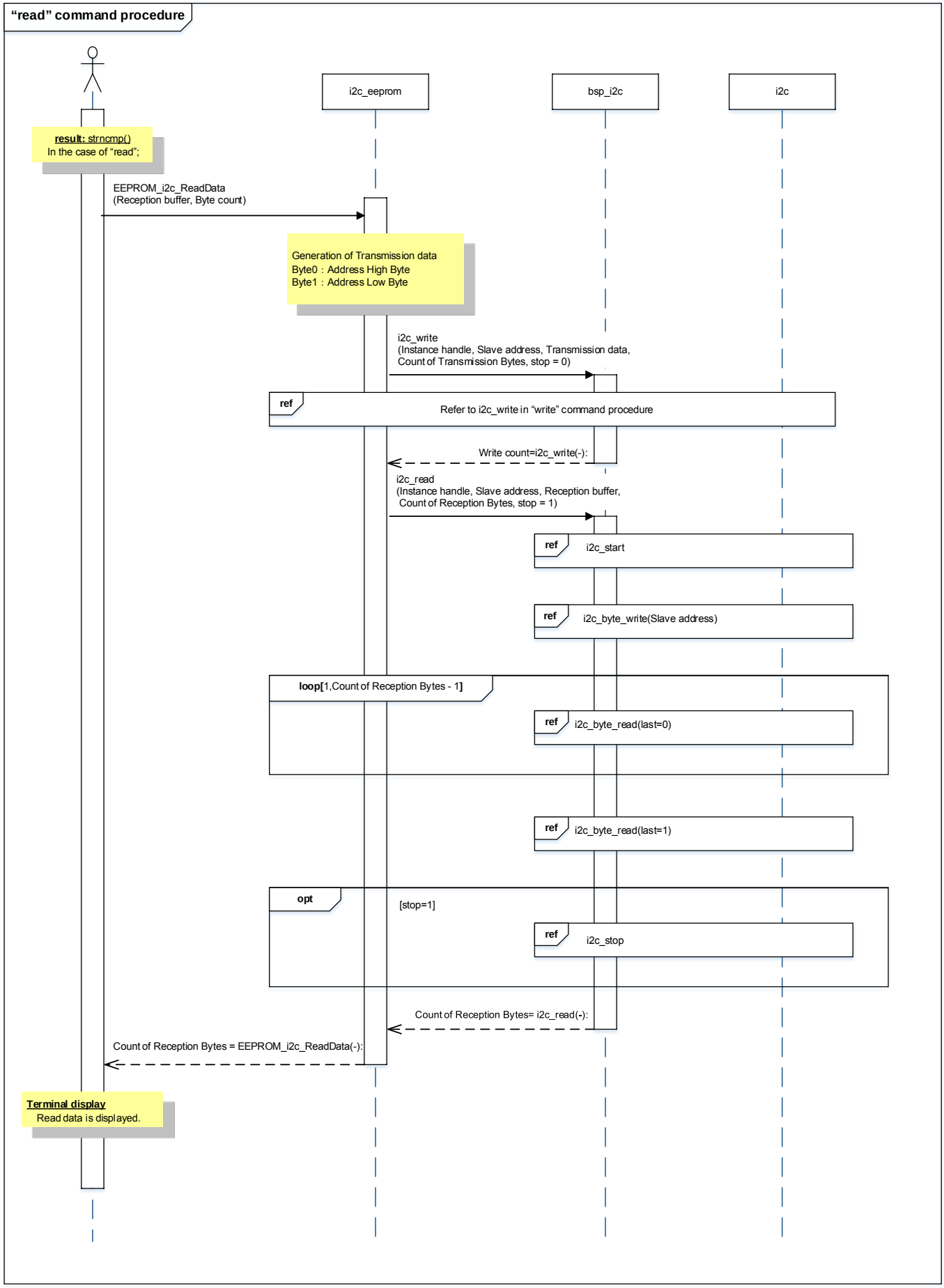


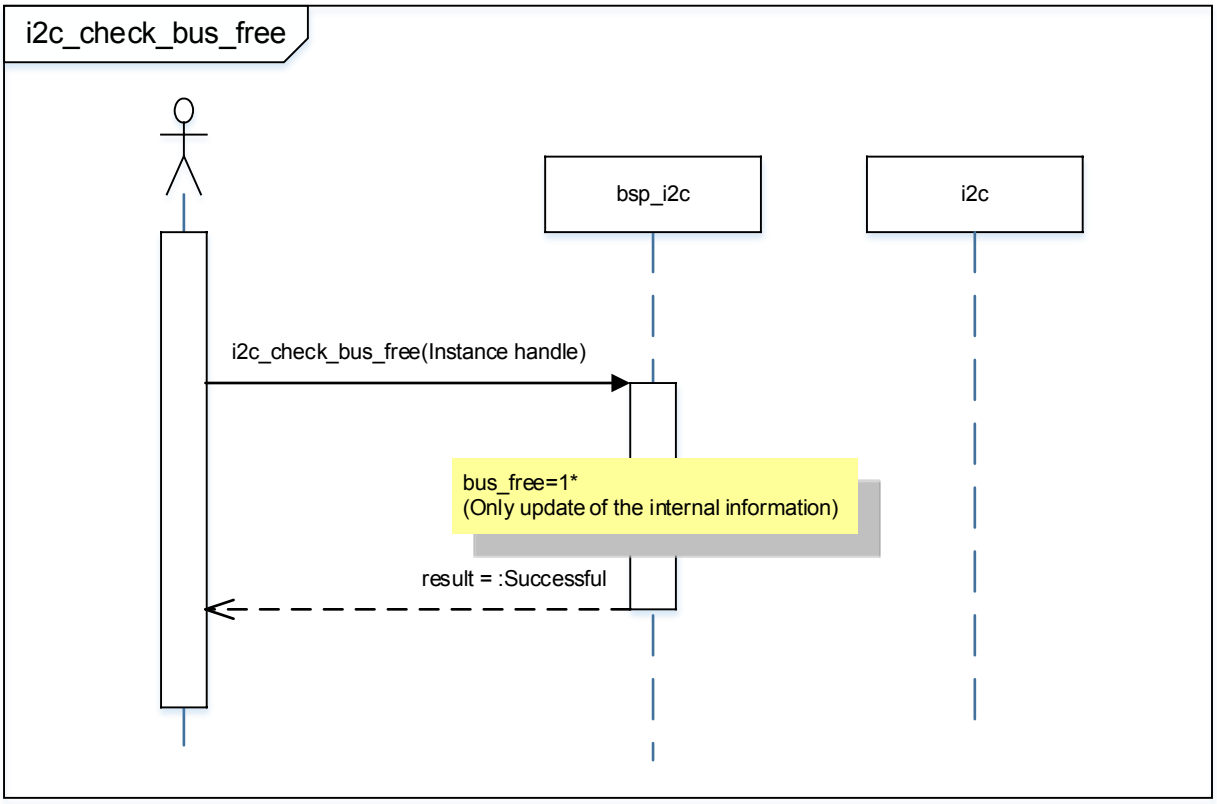

Creation and Initialization
i2c_eeprom
EEPROM_i2c_init()
Creation
bsp_i2c
i2c_init
(Instance address, sda, scl)
CG:FSYSENA
FSYSENA02（PortC）Enable
FSYSENA20（I2C）Enable
Port:
I2C0SCL and I2C0SDA settings
Register assignment
i2c
i2c_reset()
I2C_reset(Instance address)
I2C_reset(-):
i2c_frequency(100KHz)
I2C_get_clock_setting
(Instance address)
Frequency=I2C_get_clock_setting(-):
I2C initial value setting
I2C_init(Instance address)
result = I2C_init(-):Successful
result = i2c_init(-):Successful
EEPROM_i2c_init(-)

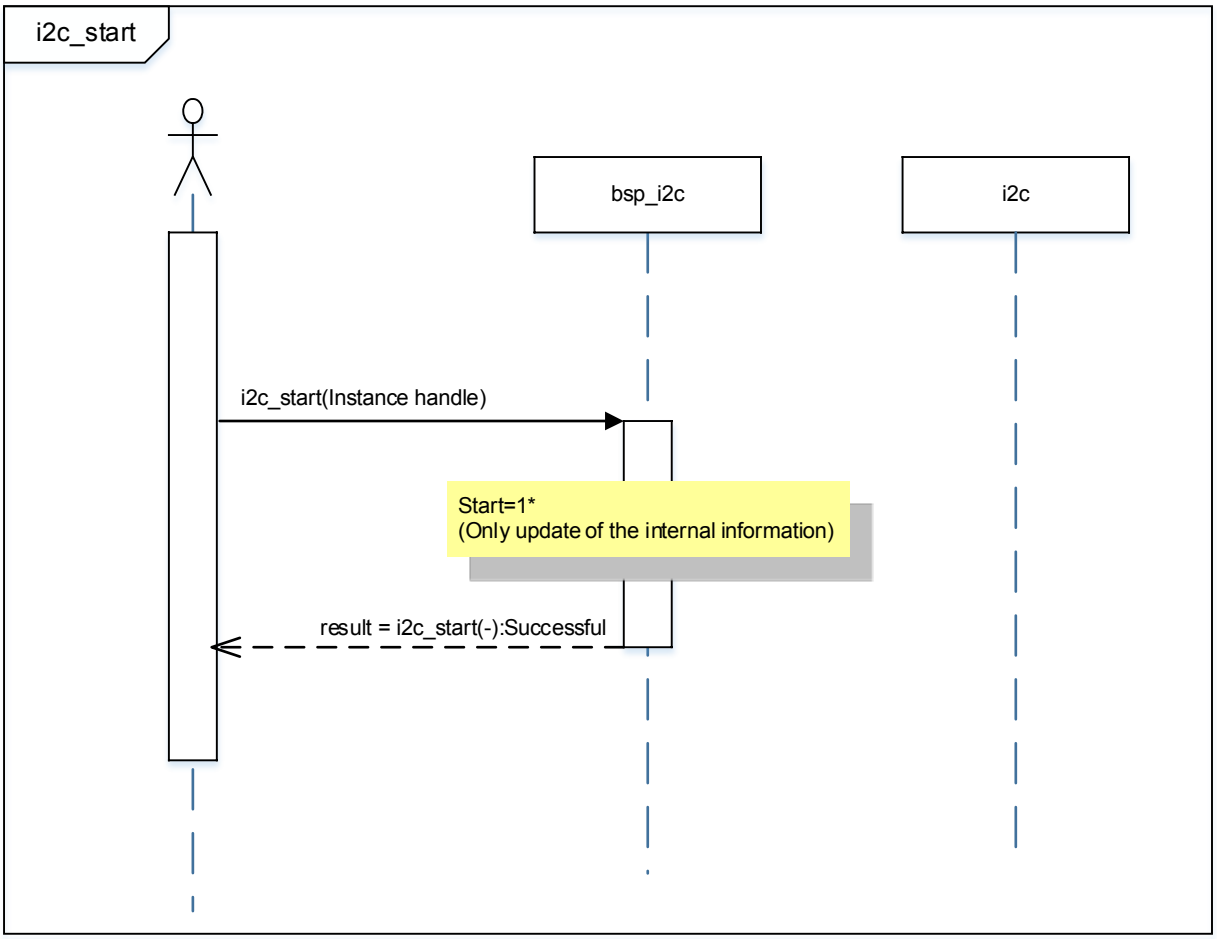
"write" command procedure

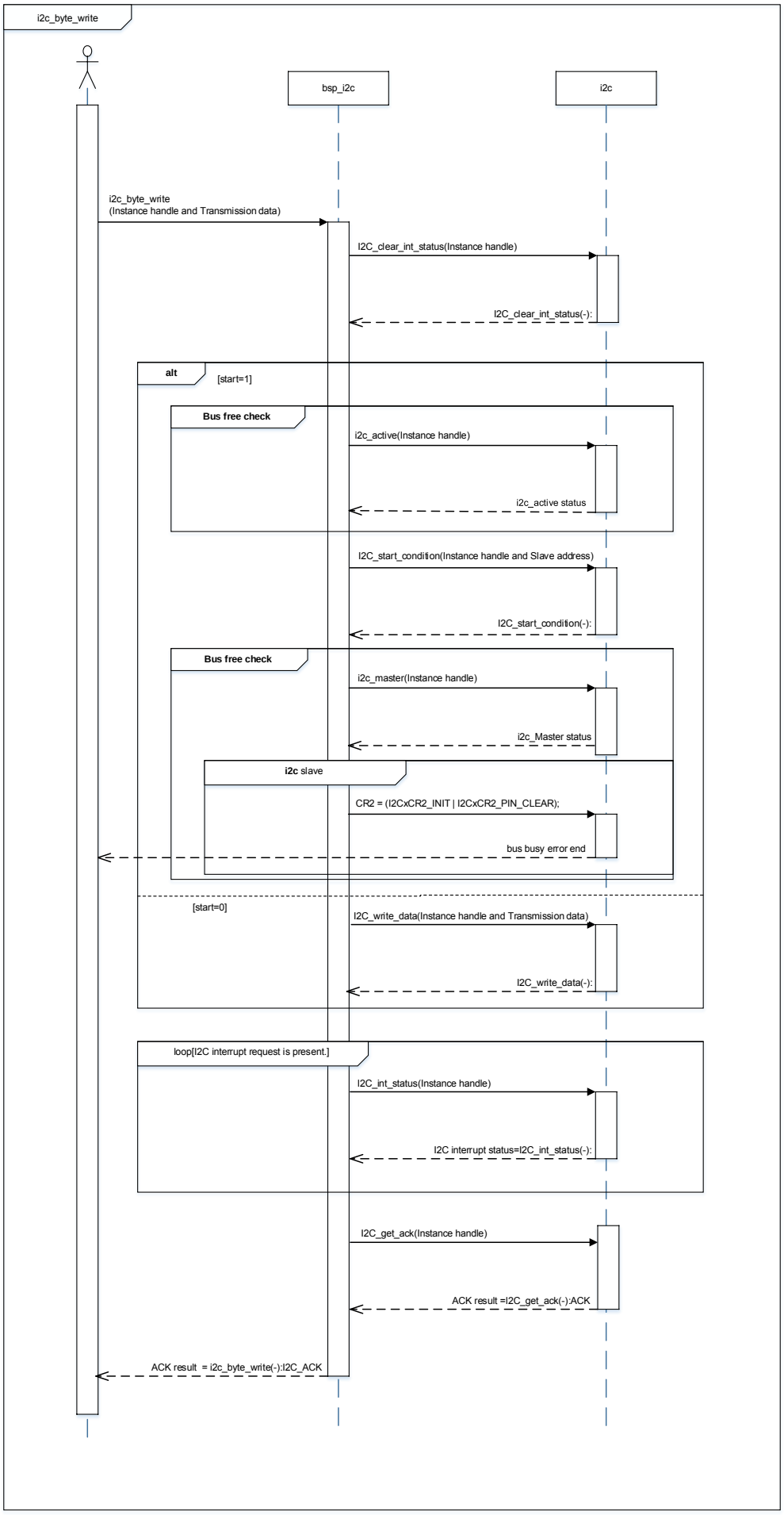


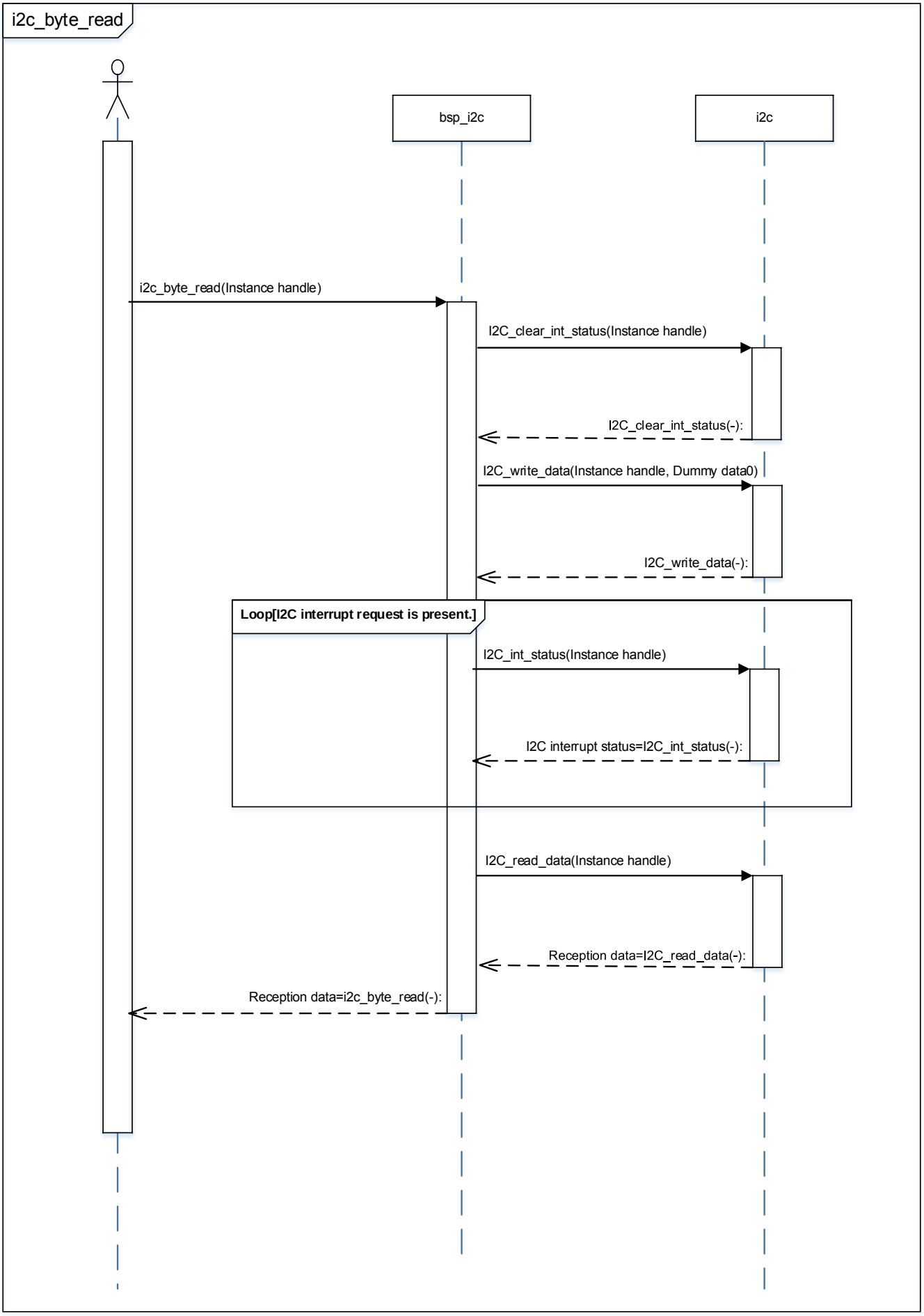
"read" command procedure

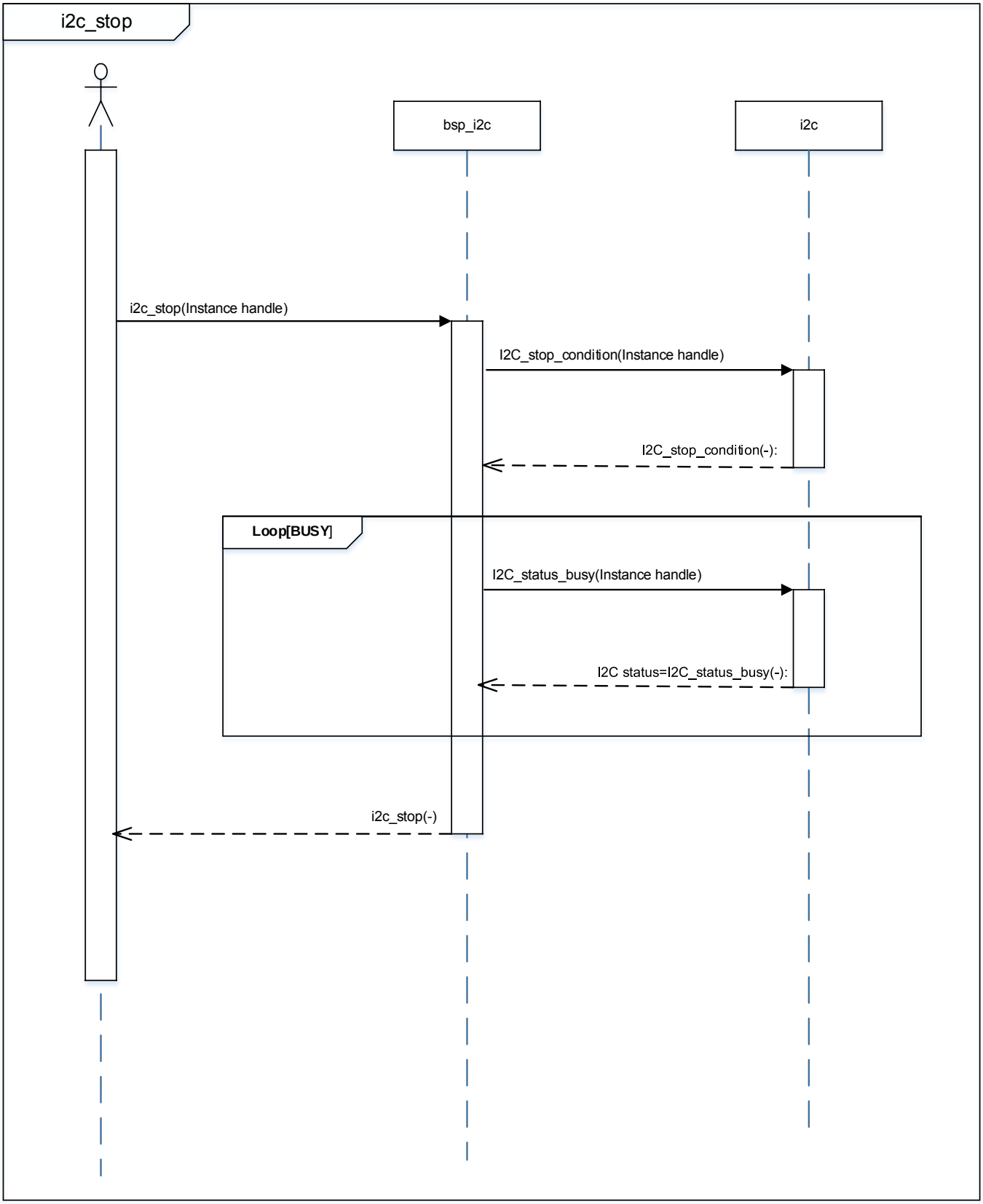



i2c_check_bus_free
bsp_i2c
i2c
i2c_check_bus_free(Instance handle)
bus_free=1*
(Only update of the internal information)
result = :Successful


i2c_start
bsp_i2c
i2c
i2c_start(Instance handle)
Start=1*
(Only update of the internal information)
result = i2c_start(-):Successful


i2c_byte_write
bsp_i2c
i2c
i2c_byte_write
(Instance handle and Transmission data)
I2C_clear_int_status(Instance handle)
I2C_clear_int_status(-):
alt
[start=1]
Bus free check
i2c_active(Instance handle)
i2c_active status
I2C_start_condition(Instance handle and Slave address)
I2C_start_condition(-):
Bus free check
i2c_master(Instance handle)
i2c_Master status
i2c slave
CR2 = (I2CxCR2_INIT | I2CxCR2_PIN_CLEAR);
bus busy error end
[start=0]
I2C_write_data(Instance handle and Transmission data)
I2C_write_data(-):
loop[I2C interrupt request is present.]
I2C_int_status(Instance handle)
I2C interrupt status=I2C_int_status(-):
I2C_get_ack(Instance handle)
ACK result =I2C_get_ack(-):ACK
ACK result = i2c_byte_write(-):I2C_ACK


i2c_byte_read
bsp_i2c
i2c
i2c_byte_read(Instance handle)
I2C_clear_int_status(Instance handle)
I2C_clear_int_status(-):
I2C_write_data(Instance handle, Dummy data0)
I2C_write_data(-):
Loop[I2C interrupt request is present.]
I2C_int_status(Instance handle)
I2C interrupt status=I2C_int_status(-):
I2C_read_data(Instance handle)
Reception data=I2C_read_data(-):
Reception data=i2c_byte_read(-):


i2c_stop
bsp_i2c
i2c
i2c_stop(Instance handle)
I2C_stop_condition(Instance handle)
I2C_stop_condition(-):
Loop[BUSY]
I2C_status_busy(Instance handle)
I2C status=I2C_status_busy(-):
i2c_stop(-)

10. Precaution

When using the sample program with CPU other than TMPM3H6, please check operation sufficiently.

11. Revision History

Rev	Date	Page	Description
1.0	2018-03-29	-	First release

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